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CHALLENGES AND PROSPECTS OF UTILIZING IRRIGATION TECHNOLOGIES (SURVEY OF GANTA-AFESHUM WOREDA, EASTERN ZONE , TIGRAY, ETHIOPIA)

BY: HAGOS NIGUSE

A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF MASTER OF ARTS IN DEVELOPMENT STUDIES (MA) SPECIALIZATION IN REGIONAL AND LOCAL DEVELOPMENT

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MEKELLE , ETHIOPIA

Declaration

I, Hagos Niguse, hereby declare that this thesis entitled **"Challenges and Prospects of Utilizing Irrigation Technologies:** Survey of Ganta-Afeshum Woreda, Eastern Zone, Tigray, Ethiopia" submitted by me in Partial Fulfillment of the requirement for the award of the degree of Master of Arts in Development Studies to the college of Business and Economics ,Mekelle University, is my original and it has not been presented for the award of any other degree, diploma, fellowship or other similar titles of any other universities or institutions.

Hagos Niguse

Mekelle University signature_____

College of Business and Economics

Department of Management Date_____

Development Studies

Certification

This is to certify that this thesis entitled "challenges and prospects of utilizing irrigation technologies: Survey of Ganta-Afeshum Woreda, Eastern Zone , Tigray, Ethiopia" submitted in partial fulfillment of requirements for the award of Degree of Masters of arts in Development Studies to the college of Business and Economics ,Mekelle University ,through the Department of Management ,done by Mr. Hagos Niguse ,ID No.**CBE/PR072/05** is an authentic work carried out by him under our guidance. The matter embodied in this thesis has not been submitted earlier for award of any degree or diploma to the best of our knowledge and belief.

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ABSTRACT

Irrigation is seen as the means of ensuring food security in Ethiopia. Thus the use of modern, advanced and resource efficient irrigation technologies is vital to increase farm output and take people out of poverty. This study is intended to examine the Challenges and Prospects of Utilizing Irrigation Technologies in Ganta-Afeshum Woreda of Eastern Zone, Tigray Region, Ethiopia. The objectives of the study is to evaluate the opportunities to use irrigation technologies , factors that influence Irrigation Technology Utilization by small-scale farmers and also looks the follow up used by the extension workers towards confirming the desirable Utilization of the Irrigation Technologies by the farmers .To serve these objectives, data was collected from 174 sample respondent farmers from four purposively selected 'kabeles' by distributing questioner and this was also supplemented by semi-structured interview, focus group discussion and observation. Descriptive type of research was applied to analyze attained data. With regard to the prospects of effective Utilization of Irrigation Technologies, the result of the study has shown that availability of labour, agro-ecology, access to money, access to markets and support of government and NGOs were identified as major factors which can be prospect for utilization of new irrigation technologies. This study also identified that the difficulty in maintaining new irrigation technologies, lack of access to spare parts and shortage of water, lack of training, uncertainty about new irrigation inputs and lack of know-how, are the most serious challenges hindering irrigation development. In addition to that, the income possible from non-crop producing activities is found to be a major inhibitor in the development and utilization of irrigation technologies. The study also tried to assess the situation on follow-up and visits by extension agents, and found that farmers have no problem with the frequency of contact with the extension personnel, but with the timing and what occurred during the visits. Weakness of Local FTCs, Weakness of extension personnel in supporting farmers were also identified as a main hampering pointes of extension service. Therefore it would be better to exploit the opportunities and address confronts that are affecting the utilization of modern irrigation technologies.

Key Words: *Irrigation Technologies, Extension Service, Spear Parts, Technology Utilization, Small-scale Irrigation.*

Table of content

Acronyms

AAAE	African Association of Agricultural Economists
ABWGA	Annual Book of Woreda Ganta-Afeshum
ADCS	Adigrat Diocesan Catholic Secretariat
DA	Development Agent
DFID	Department for International Development
FAO	Food and Agricultural Organization of United Nations
GTP	Growth and Transformation Plan
ICID	International commission on irrigation and drainage
IFPRI	International food policy research institute
IWMI	International water Management Institute
MoARD	Ministry of Agriculture and Rural Development
MoWE	Ministry of Water and Energy
MUS	Multiple use water systems
NGO	Non Governmental Organizations
OLS	Ordinary Least-Squares
OARD	Office of Agriculture and Rural Development
REST	Relief Society of Tigray
SPSS	Statistical package for social sciences
SSA	Sub-Saharan Africa
TRPFB	Tigray Region Plan and Finance Bureau
WB	World Bank

List of Tables

List of Figures

CHAPTER ONE

INTRODUCTION

This chapter deals about the overview of different concepts in relation to challenges and prospects of utilizing irrigation technology. Thus, the Background, Statement of the Problem, Research Questions, Objectives, Scope and Limitation, Significance and Organization of the Study are discussed.

1.1. Background of the Study

The world's population is predicted to reach nine (9) billion by 2050 A.D., resulting in more than 2.3 billion extra people to feed. Besides, ⅓ of the world's population, mainly in Asia, the Middle-East and Sub-Saharan Africa (SSA)will face absolute water scarcity by the year 2025; hence policymakers, researchers and non-government organizations (NGOs) are using various technical, institutional and policy-related interventions to match world food production to the growing population; (FAO, 2011; IWMI, 2006).

While land degradation, e.g. desertification due to natural stripping of topsoil, is a major factor in decreased output from agriculture, expansion and promotion of Irrigation Technology usage, frequently prioritized in developing countries, is among the common interventions and strategies used towards improvement. The main objective of bodies promoting irrigation technologies is to improve productivity, to raise incomes by increasing harvests and to enhance food security at household level; indeed, water saving and production-enhancing technology play a central role in overcoming food security challenges. As a result, many governmental (GOs) and NGOs are actively engaged in promoting these technologies (Margarita et al, 2013). Dose (2006) strongly suggested that promotion of efficient utilization of water resources, through irrigation technologies, should be an important strategy for governments in developing countries.

Regarding developing countries - especially in sub-Saharan Africa - Liang (2008) revealed that, even if irrigation has the potential to boost agricultural yields by (at least) 50 percent, food

production is low due to both insufficient rainfall and little use of Irrigation Technology. Compared to 37% in Asia and 14% in Latin America, the irrigated areas of sub-Saharan Africa, which extends to more than 6 million hectares, comprises a mere 5% of the total cultivated area. David and David (2000) stated that farmers in developing nations are uncertain (and often ill-informed) about the properties and performance of the new irrigation technologies, and those uncertainties explains the low usage of new irrigation technologies.

Ethiopia is a SSA country characterized by a low standard of living and widespread poverty; drought conditions are frequent, and farming is often small scale/subsistence, traditional and rainfall dependent, with limited (or no) access to the various irrigation technologies and institutional support services. As a result, with the majority of farmers depending on rain-fed agriculture, the country's agricultural economy is extremely weak and exposed to the impacts of weather and climatic unpredictability, which often leads to partial or total crop failure, resulting in food shortages. Although the country has 4.5 million hectares of irrigable land, a mere 0.16 million hectares 3.6% of the total irrigable land is actually watered artificially (Awulachew .S .B, 2007). This author added that the promotion of irrigation technologies in Ethiopia is recognized as the most basic and best opportunity for increasing agricultural output towards feeding the growing population. Though many stakeholders recognize the importance of these technologies, utilization at farm level is poor. For this reason, while small scale water technology is still relatively new in Ethiopia, the government has already planned to actively promote irrigation systems.

Furthermore, in his study on irrigation development, Yalew et al (2011) argue that irrigation technology in agriculture is expanding, with a wide geographical spread; but, its contribution to the overall economic development of the country is not as high as it should be. Consequently, the Federal Democratic Republic of Ethiopia has prioritized the development and use of irrigation methods, towards enhancing and improving agricultural production - thereby improving the food security situation. Utilization of irrigation technologies is fundamental to reducing the ever-increasing pressure on land, especially in the highlands, by increasing the productivity of a unit of land; there is also a commitment to cultivate ‘new land’, predominantly in the lowlands, where population density is lower, comparatively, and uncultivated land is abundant (Yalew et al, 2011).

Characterized by subsistence farming households, raising predominantly cereal and vegetable crops for local consumption and sale, Tigray Region is one of the most land-degraded regions of Ethiopia. Indeed, the pace of population growth and crop production in the region are not matched, mainly due to recurrent droughts, environmental degradation, the non-use of irrigation technologies and limited institutional support services. In response to this severe environmental degradation and population-resource imbalance, the Tigray Regional Government has initiated a major rural production-enhancing mechanism, e.g. construction of several small-scale dams and supplying various water-saving technologies, but farmers (as yet) are not fully using the technologies (Kinfe, 2012).

In their study of the Tigray Region, Nata and Bheema (2010), illustrate that farmers are not taking advantage of irrigation technologies, often due to water scarcity; rainfall is seasonal, and many farmers are not yet informed or convinced of the need and the skills to harvest and save water during the rainy periods. In fact, the community (in general) in these areas has little awareness of water management and use, not least water-saving technologies and irrigation.
Ganta-Afeshum wereda, a division of Tigray National Regional State, is a good example of the lack of awareness and use of water management and technology. According to the annual report of Ganta-Afeshum wereda (2013), there is an ongoing effort at supplying various modern water-saving irrigation technologies, e.g. drip and treadle pumps, by Regional Government and NGOs, e.g. ADCS however, farmers are not utilizing these technologies efficiently or effectively, and many of the modern irrigation technologies supplied are defunct.

Governments, NGOs and other concerned bodies, therefore, recognize that the adoption and use of new irrigation equipment is a fundamental line of attack towards ensuring food security and thereby reducing poverty; it is important then, to study the real challenges which are contributing to under-utilization of modern irrigation technologies. Accordingly, this study is intended to assess the realistic prospect, and challenges to, irrigation technology usage in Ganta-Afeshum ‘wareda’ in the Eastern Zone of Tigray National Regional State.

1.2. STATEMENT OF THE PROBLEM

In consideration of agriculture as a major source of income for the majority of rural households, a number of investments have been made in promoting various irrigation technology systems in many African countries. This intervention is mainly through the introduction of diverse irrigation systems and schemes, in community or collective ownership, and provision of these small scale technologies through credit, funding or other ways of distribution, even though the expected success was, in general, limited by many factors.(Manje and Snelgrove, 2010).

In both developed and developing countries, investigation of diffusion patterns of modern irrigation technologies are at the core of several empirical studies. These empirical studies revealed the poor adoption and use of irrigation technologies, stating that limited trained manpower, inadequate extension services, the cost of irrigation equipment, educational level and experience of household members and environmental conditions like soil quality are the main contributing factors (Andrew et al, 2013; Nata and Bheem, 2010; M.H. Ali, 2010).

Awulachew (2010) and MoARD (2O11) indicated that Ethiopia has abundant water resources, land, irrigation potential and diversified agro-ecological which is suitable for growing of various crops; however, its agricultural systems do not yet benefit fully from the technologies of water management and irrigation because of limited access to agricultural technology, limited possibilities to diversify agricultural production - given underdeveloped rural infrastructure - and little access to agricultural markets and technological innovations. These issues, combined with the increasing degradation of the natural resource base, especially in the highlands, aggravate the incidence of poverty and food insecurity in rural areas. In summary, the potentially enormous agricultural system is dependent on rain fed agriculture, with very limited areas currently developed, under traditional irrigation systems which are incapable of satisfying the country's food requirement; hence, the country is heavily dependent on foreign food aid (MoA, 2O11).

The Bureau of Agriculture and Rural Development, in its annual report (2013), described how 54,302 new irrigation technologies were distributed in the region. Of this number, the total of schemes utilized effectively is less than was expected even if it was failed to put it in hard fact. And the situation indicates that the demand for new irrigation technologies is lagging behind, despite the positive progress on the supply side. This gap is also recognized as one of the impediments obstructing realization of the Five Year Growth and Transformation Plan (GTP).

According to Margarita et al (2013), farmers should acquire enough awareness about the advantages and manipulation of any new farm technology, mainly from training by extension personnel (from either private, NGOs, or public extension agencies), and this is considered as a necessary condition when planning to establish modern agricultural systems to this end extension personnel have a great role.

In this concern Berhanu et al. (2006) demonstrated that as the speed of agricultural growth depend in the speed of current subsistence oriented production system is transferred into market oriented production system in Ethiopia, the agricultural extension service have a key role. Since it contributes to the development of the skill and knowledge of farmers to adopt and utilize new and improved technologies and animal, and the approaches and processes with which the skill development and access to information are realized although there are many problems to practice in the ground level.

Despite this fact, the Annual Report of 'wereda' Ganata-Afeshum (2012) shows that of the 13,575 households in the 'wereda', only 58% have had access to the relevant training courses. The situation indicates clearly that the farmers are not getting full information and training on maintenance and use of the available irrigation technologies. By the end of 2013, approximately 1,035 new irrigation technologies were owned by farmers in the study area, but the number of households who practiced irrigated agriculture is modest.

Intensification is deemed to be a necessary pre-condition for the development of the agricultural sector of Ethiopia. To this end, various governmental and NGOs initiated small-scale irrigation schemes throughout the country, including the Tigray region.

Despite these efforts, however, small-holder farmers, particularly in the study area, are found to be reluctant to participate in these small-scale irrigation schemes. In this regard, in the mid-term report (2012) on its food security project, the ADCS revealed that not only new users, but several previous beneficiaries, had either not started or had abandoned technologies such as drip irrigation. From already adopted irrigation technologies in the study area, 65% approx. are functional and the remaining 35 % are non-functional; specific to drip irrigation technologies, almost 100% are non-functioning. Accordingly, ADCS has recommended further research to investigate challenges hindering full utilization of those modern irrigation technologies.

Many researches, e.g. Andrew et al, (2013), Nata and Bheem, (2010), M.H. Ali, (2010) and Awulachew.S .B. (2010) stated various reasons for the low level of adoption by farmers of irrigation technology, but failed to address the challenges and prospects of utilization of those technologies. In recognizing and evaluating the challenges and prospects in their study area, there are omissions by these researchers, and there is a lack of specific research related to particular geographical areas. Hence, to fill these gaps in research, further study and empirical evidence are needed, towards pointing out challenges and prospects of utilizing irrigation technologies at grass root level. Therefore, the existence of such omissions in previous studies has prompted this researcher to raise the issue under consideration. Taking this in to consideration the main aim of the proposed study is to investigate the following questions:

1.3. Research questions

- What are the prospects of Irrigation Technologies being used in the Study Area?
- What are the main Challenges that can hinder full utilization of Irrigation Technologies in the Study Area?
- What is the state of extension service towards ensuring the efficient and effective use of Irrigation Technology by households in the Study Area?

1.4. General objective

The general objective of this study was to assess the challenges and Prospects of Utilizing Irrigation Technologies, in Ganta-afeshum Woreda in Eastern Tigray, Ethiopia

Specific Objectives

The specific objectives of this study will be as follows:

- Assess the basic factors that influence Irrigation Technology Utilization by small-scale farmers in the Study Area.
- Evaluate the opportunities to use irrigation technologies in Ganta-afeshum woreda.
- Asses the extension service towards confirming the desirable Utilization of the Irrigation Technologies by the farmers in the Woreda.

1.5. Scope and Limitation of the Study

The study covers four 'kebeles' (sub-areas) only of Ganta-Afeshum Woreda, in the Eastern Zone of Tigray National Regional State; the study did not addressed the other parts of Tigray Region. It was specifically focused on the challenges and prospects of Utilizing Irrigation Technologies in Ganta-afeshum Woreda. Together with this, the research assessed the prospects of using Irrigation Technologies, the socio-economic and institutional challenges that hinder the utilization of irrigation technologies and the extension service. On the other side, this study employed the survey method; hence cross sectional data was collected from the sample respondents as the study takes place, and comprised analysis of the descriptive type.

Because of no study without limitations in designing, this study had also have its own methodological limitations .Specifically the study area has 20 'kabeles' but the researcher taken only four 'kabeles' hence this have its own effect on representation. Even though the study used mixed approach, to the degree that the topic was about challenges and prospects it leads to more of qualitative thus it did not used any model rather than descriptive analysis hence this limit to put scientific analysis and results. The study also used simple random sampling method to select respondents' from the four 'kabeles' moreover this was one limitation to select appropriate respondents hence this method have its own limitations.

1.6. Significance of the study

The findings of this study can serve as a significant input for various development agencies/actors working on the specific area of irrigation, or for other related development areas, by revealing the challenges and opportunities related to irrigation technologies. In this way, it is intended that the research will have the following significance:

- It will inform policy designers, implementers and NGOs of the important factors in efficient and effective installation, maintenance and use of irrigation technologies, and the various challenges militating against their full exploitation.
- The finding will serve as input in designing future irrigation development programmes.
- It will provide significant information for researchers wishing to assess the challenges of utilization of irrigation technologies.
- It may help as input in promoting the implementation of modern irrigation technology.

1.7. Organization of the Study

The study encompasses five chapters. The first chapters traces the introduction which includes background of the study, the statement of problem, the research questions, objective as well as the scope and limitation of study with its significance. The second chapter is about the review of literature which deals with an overview, concepts and definitions, historical perspective, challenges, prospects, extension services, previous studies and the case in Ethiopia in relation to irrigation technology utilization. Section three is concerned with the methodology of the study which includes the data types and sources, research strategy and design, data collection procedures and analysis. In the fourth chapter discussions and analyses of the study was stated. Finally, the study was presented conclusions and recommendations based on the findings.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter, presents about different concepts so as to give all-inclusive understanding about challenges and prospects of irrigation technologies. Accordingly, definitions and concepts, historical events, prospects, challenges, empirical evidences from other world and Ethiopia as well as overview of extension service in relation to the subject under study are presented.

2.1 Definitions and Concepts Related to Irrigation Technologies

2.1.1 Irrigation

Irrigation is defined as the artificial application of water onto cropland for the purpose of satisfying the water requirements necessary for growing various crops; it plays a key role in stabilizing food production in a number of countries by either supplementing or replacing the need for natural precipitation for the purpose of food production (L. Shanan, 1987:1)

Once more, irrigation modernization defined as a process of technical and managerial upgrading of irrigation systems combined with institutional reforms, with the objective to improve resource utilization (labor, water, economic, environmental) and water delivery service to farmers (FAO,2003:5).

2.1.2 Small Scale Irrigation System

Many development organizations perceive that small-scale irrigation systems are vital in enhancing production systems; due to its management simplicity, a single farmer can control the irrigation of up to 200 hectares (Tesfa, 2011).

FAO (2003) explains that the expansion of small-scale irrigation, mainly in developing nations, is a basic priority in mitigating drought, and it is a way forward for sustainable agriculture and macro-economic development for a nation. Once smallholder irrigation schemes are designed carefully, the effect is observed in terms of increased productivity, improved income and

nutrition, increased employment opportunities and food security. Therefore, smallholder irrigation systems are advantageous in many respects and can provide profitable and reliable experience for policy makers, on how to formulate sound policies, especially related to different water saving technologies.

According to many scholars, small-scale irrigation technology has a further advantage; it can enhance the livelihood of rural communities through climate adaptation, food security, and poverty reduction (Steve, 2009).Usually used on small plots, small-scale irrigation is that in which farmers (individually or in groups) have the major control and using a level of technology which they can effectively operate and maintain (Steve, 2009).

According to Yusuf and Tena (2007, cited in Tesfa, 2011), irrigation systems can be categorized based on size, source of water, management style, degree of water control, source of innovation and type of technology. In Ethiopia, irrigation schemes are currently managed at various levels, e.g. by Government, by individual farmers or by groups. These include traditional irrigation schemes, modern small-scale irrigation scheme, modern private irrigation and public irrigation depending on the size and type of technology, type of management, the degree of water control and size of the land holdings.

2.2 Short History of Irrigation Development in the World

According to (FAO, 2003) the history of Irrigation goes back over 5,000 years ago. Accordingly In the coming paragraphs' will discuss in short about the history of irrigation development. Due to the scarce of natural rainfall to produce crops Mesopotamia and Egypt started irrigation practice around 6th millennium BCE, according to Archaeological investigation.

Beside to that, the earliest record of irrigation in the New World were found in the 'Zana' Valley of the Andes Mountains in Peru, the remains of three canels radiocarbon old from the 3rd, 4th millennium BCE, and the 9th century were found by archaeologists. Civilization of Indus Valley in Pakistan and North India (from 2600 BCE) additionally had an early canal irrigation system.

Generally, through the experience that they got from former civilizations the new comers were started to practice sophisticated irrigation in many area of the world (L. Shanan, 1987).

Some of the irrigation method inherited and still using in some world such as in Asia, the Middle East and North Africa, this is mainly the Qanats, developed in antediluvian Persia in about 800 BCE, which is the oldest kenned irrigation methods. This method holds a kind of network of vertical wells and gently sloping tunnels driven into the sides of cliffs and steep hills to tap groundwater (FAO, 2003).

After wards mainly in around 1441 CE, Korea found the world's first dihydrogen monoxide gauge (woo ryang gyae) by the inventor who was called Jang Young Sil, a Korean engineer of the Choson Dynasty, under the active direction of the King, Se Jong. It was installed in irrigation tanks as a component of a nationwide system to quantify and amass rainfall for agricultural applications. With this instrument, planners and farmers could make more preponderant utilization of the information amassed in the survey (L. Shanan, 1987).

Accordingly, it is said to be History is the greatest teacher of the mankind. Study of the history of irrigation, development of irrigation technology, sustainability of the old irrigation systems provides an insight into the factors that have sustained the outcomes over the generations (ICID, 2013).

In general, irrigation in some countries is an old art - as old as civilization - but for many nations of the world, it is a modern science, the science of survival. Even if irrigation is one of the oldest identified agricultural techniques, improvements are still being made in irrigation methods and practices (FOA, 1997/98/99:1) cited in Eliyas (2011).

2.3. General Assessment of the Irrigation Sector in Ethiopia

According to Yalew et al, (2011) irrigation development in Ethiopia, mainly small-scale irrigation, has a long history; however, modern irrigation started in the 1950s with a collaboration of the Ethiopian Government and a foreign company, concentrating mainly on the commercial irrigated farms in the Awash Valley.

As Eliyas (2011) describes, irrigation in Ethiopia started with the arrival of Semitic immigrants from Yemen and, possibly, agriculturalists from Sudan. According to Eliyas, seed cultivation involving irrigation was introduced to Northern Ethiopia – in the era of the Axum Empire in 1000 B.C. - by both groups. From this, we can appreciate and understand that irrigation in Ethiopia could scarcely be described as a modern practice.

However, the rapid growth of the global population has necessitated an increase in crop production throughout the world, and this in turn has led to rapid expansion of irrigated agriculture, especially small-scale irrigation applied in different forms of water saving technologies (Ibid).

Yalew et al, (2011) in his study on irrigation development in Ethiopia, argues that irrigated agriculture is expanding and widespread, but its contribution to the overall economic development of the country is not as required, due to little utilization of the technology, and other factors. Consequently, the Federal Democratic Republic of Ethiopia has given top priority to development and utilization in the irrigation sub-sector, towards enhancing agricultural production and thereby improving the food security situation.

2.4. Uses of Irrigation Technologies

Irrigation technologies have a significant role in increasing productivity, towards ensuring food security at national and household level. The effect is also observed in an increase in the supply of raw materials for domestic agro-industries and improved export earnings. The Ethiopian

government has given high priority to irrigation development mainly by expanding different irrigation technologies that can boost production and save water (Yalew et al, 2011).

In his study, Tesfa (2011) revealed that irrigation technologies can increase the supply of water for various agricultural activities, thereby increasing production. It provides the farmers with more crop planting systems. Irrigation technologies have a vital role in saving water throughout the season, which boosts production and reduces exposure to water shortfalls or seasonal droughts**.**

Utilization of irrigation technologies is also fundamental to reduce the ever-increasing pressure on land, especially in the highlands, by increasing the productivity of a unit of land; it also helps, to a lesser extent, by bringing new land under cultivation, predominantly in the lowlands where population density is lower, relatively, and uncultivated land is abundant (Yalew et al, 2011).

The same source concludes that the development of irrigation technology is necessary in modernizing the country's agricultural economy, and the investment in this area can significantly improve the rural income through increased agricultural production and productivity.

According to the experience of many countries, recurrent drought and uneconomical use of resources, chiefly land and water, are taken as the main elements in food insecurity and poverty. Therefore irrigation technology plays a significant role in combating the effects of recurrent droughts; it also sustains production with the efficient and effective use of the available resources, in order to primarily alleviate the problem of food insecurity and thereby alleviating poverty (Ibid).

Furthermore, according to Nata and Bheema (2010), irrigation creates job opportunities for the households in the area. As a result, members of households are involved in irrigation activities as full-time/part-time labourers. It is true that the growth of population requires an increase in agricultural production. And the development of irrigation is seen as a significant means to fill the gap in arid and semi-arid regions. In many places, the need for more arable land has led to deforestation, which in turn has intensified the disturbance of the ecosystem. In order to address

these problems, different irrigation technologies, that can boost agricultural production in a small plot of land, are being introduced (H. Ali, 2010).

J. Z. Ohikere and Ajogwu (2012) in their study examined the impact of small scale irrigation technology in crop production in the Fadama areas of Kogi State in Nigeria. The data taken from 96 farmers engaged in various crop projects in Fadama, has revealed that cultivation of small holdings using simple farm tools and pump irrigation technology can produce more than one type of crop, and they are very profitable: in summary, the farmers experienced considerable success and an enhanced livelihood.

Norman (1996, cited in Mohammed, 2002) lists the benefits of irrigation development as Professional attitude to resource use, Reducing uncertainties ,Growing the capacity of the land for input and also vital in Escalating the size of total farm business and Enhancing the economic fortunes of farmers and alleviating their problem in the event of adverse conditions or disasters.

2.5. Prospect of Using Irrigation Technology in Ethiopia

In identifying the major factors which would contribute to the successful development of irrigation technologies throughout Ethiopia, the Department for International Development (DFID) (2007) mentioned the following: the existence of a favorable natural environment, government policies, predominant presence of diverse and suitable agro-ecologies and abundant natural resources, the promising potential of improved technologies, and the government's commitment to improve the sector.

Additional factors mentioned by DFID were: the existence of a young generation with relatively better training and knowledge, an increasing need and interest among farmers to use new technologies, favorable markets and access to international markets. “We have fertile ground in which to plant the new irrigation technologies”, concluded DFID.

Awulachew, S. B (2007) listed and described opportunities to exploit new irrigation technologies worldwide, mentioning accessibility of new irrigation technologies which will be upgraded

through research in the future, high water potential (especially through rainfall) almost in every region, highly-committed governments, donor and NGO support for development activities and opportunities for improving the knowledge base of policy makers, planners, designers, etc.

According to the geological map of Tigray, Alamata and its surroundings Mokoni corridor, Mekelle, Mai-Kadra, Bereket, Rawyan, Turky, Shigeli, Rubas, from Adebay up to Adigeshu, Tekeze areas and Sheraro are sites which have rich ground water. In Badime and its surroundings, Waldiba, Ramma Axum-Shire line, Guya, Haiki-Meshal, Wukro-Tsigereda, there are a further 44 sites which have reasonable ground water. This ground water is, then, a natural asset that can be used for irrigation and potable water production in the region (Tigray Region Plan and Finance Bureau, 2010/11-2014/15, p.43, 44).

2.6. Promotion of the Utilization of Irrigation Technologies

Dose (2006) strongly suggests that promoting the efficient use of water resources through irrigation technologies should be a major concern of developing countries' governments. The basic objective of promoting small-scale irrigation is to increase farmer's involvement in the design, implementation, operation and maintenance of irrigation technologies (Carter and Howsam, 1994, cited in Tesfa, 2011).

In Africa, public mobilization, assisting and motivating suppliers of modern technology, promotion through accessible media, and development and implementation of small-holder farmer-centered policies, have a significant role in irrigation technology development. In addition, research institutes have a great significance in information sharing and promotion of farm research, in partnership with the extension personnel and the local farmers (Takeshim, 2010).

This author also lists some factors which would motivate farmers to adopt and use the irrigation technologies; he mentions technical assistance, availability of finance and credit and integrated marketing systems among farmers. To this he adds the involvement of the private sector and the

improved supply of fresh produce to the market, by farmers with a better standard of living through improved income from a market-oriented system.

2.7. Challenges in Utilizing Irrigation Technology

2.7.1 Empirical World Evidence

There have been many studies to identify challenges to the introduction, use and development of irrigation technologies. Doss (2006), Adeoti et al (2009**)** and others disclosed important factors affecting the adoption and attitudes of farmers towards using the new technology. These include government policies, technological changes, market forces, environmental forces, demographic factors, institutional factors and delivery mechanisms in general.

According to a study conducted in Ghana in 2011 by Daniel, some causes of under-utilization are identified as: non-adherence to decisions taken during the project planning stages, poor construction work, low technical capacity of agricultural extension agents, and weak management of Water User Associations. Under-utilization can be minimized by involving farmers in the irrigation planning process, and the creation of an enabling environment whereby farmers produce efficiently and have access to markets for their crops. Another study by Adetola (2009)in Ghana obtained data from 108 farmers, i.e. 52 adopters of irrigation technology and 58 non-adopters; the study showed that availability of labour and numbers of extension visits per year are factors that can affect the adoption and utilization of irrigation technologies.

Whereas Takeshima et al (2010),Tiamiya (2009) and Bagheri and Ghorbani (2010) and many other findings from empirical studies displayed that type of information and farmers' awareness on designed type of information are major challenges to creating/maintaining demand for irrigation technologies .

But, unlike the former findings, David, S. and David, Z, (2000) stated that farmers are uncertain about the properties and performance of new technology, and that these uncertainties lead to low exploitation of irrigation technologies. The researchers have noted that not much research has been conducted to understand this aspect of agricultural and technological change.

They also recommended that a large body of empirical evidence regarding geographic concentration of new technologies and geographic patterns of technology adoption may be linked to considerations of marketing and product support efforts. New technologies are more likely to be adopted and used earlier near market centres where sellers and product supports are easily available. Agricultural industries and certain types of technologies may be clustered in certain regions, especially in the earlier life of a new technology, and these regions will generally be located in areas that have technical support and expertise associated with the maintenance and development of the technologies to decrease risk uncertainties of farmers**.** Furthermore, they also showed that considerations of marketing and geographic locations are two areas where more research should be done.

The study that had been done by Justine Liberio (2012)in Tanzania also indicated that the main factors limiting the farmers from utilizing irrigation technologies to the desirable extent are low education level, family size, farming experience, availability of markets, and frequency of contacting extension officer .

Nevertheless, results from empirical studies from Selected Localities of Maharashtra and Gujarat States of India by Regassa et al (2005) revealed that ownership of dug wells and bore wells had a strong effect on the probability of execution of irrigation technologies in both states. This is due to well owners having a high degree of control over the water source and the motivation to use the available water in the wells efficiently. Concerning the age of farmers adopting the new technologies, and contradictory to many studies, Regassa et al, (2005) found that age has no significant role since the older farmers have a lower chance of acceptance of new innovations and technologies before going to utilize.

Farah & Bahaman (2013), in their study in titled Factors Impinging Farmers' Use of Agriculture Technology in Malaysia, concluded that farmers' perceptions and levels of education, as well as extension-workers' knowledge, the management of the extension programme, and the physical conditions of the area, are all factors that affect technology adoption and use among farmers .

M.H. Ali (2010) disclosed that Water Source scarcity is the main challenge in utilization of irrigation technologies; so, at the time of scheduling and development of an irrigation project, source(s) of water should be identified, to ensure a continuous water supply. Furthermore, he recommended that in water resource development, some factors are essential; he listed harmonization of the various demands for water, establishment of irrigation priority rights between upstream and downstream users, and consideration of the rights of the existing users of water from flooding - which may be modified by dams.

From their study in Ghana, Gyasiet al (2006 cited in Nhundu, k. and Mushunje, 2011)concluded that access of higher wages or other options outside the schemes increase the opportunity cost of labor and reduce the incentive for household's participation in irrigation programmes. In addition to that uncommitted, non-transparent and rent-seeking attitude of management are publicized to be an important concern that can hinder the interest of households to engage in irrigation schemes.

2.7.2. Empirical Evidence from Ethiopia

The study Conducted in Tigray Region by Nata and Bheema (2010) revealed that Irrigation technology utilization is considered as an advantage to boost food security in the area. However, maintenance skills and spare part provision are seen as main challenges. According to the response of the beneficiaries, maintenance and repair of the technology are serious problems, as the technical support available is often based in towns located far from remote farms.

The other study, 'Assessment of Small Scale Irrigation and Water Harvesting in Ethiopian Agricultural Development' by Awulachew, S. B(2006) showed that low utilization of some small-scale irrigation technology is related to a number of issues such as limited capacity (of farmers), institutional instability, defective project design and lack of adequate community consultation during planning.

Agricultural intensification is presumed to be a necessary pre-condition for the development of the agricultural sector in Ethiopia. As a result, various GOs and NGOs and other agencies initiated irrigation technologies throughout the country including the Tigray region. Despite

these efforts, smallholder farmers are found to be reluctant to participate in such schemes. The case study conducted in Laelay Maichew district in Central Tigray, by Knife et al (2012)argued that income, gender, access to market information and health condition of households are found to be important challenges to participation and utilization of irrigation technologies.

Furthermore, the study entitled 'Social, Economic and Institutional Factors Affecting Utilization of Rainwater Harvesting Technology, in Eastern Tigray',by Abadiand Tesfaye (2006), with a sample of201 households, mentioned several variables militating against the introduction of the technologies; extension contacts, training, animal product income, market distance, location, cash availability, farmland size and input, demands of labour and land costs, skills and knowledge of farmers were listed.

In his study, which involved a sample of 301 farm households taken through a logit model and an ordinary least-squares (OLS) regression, Tadesse et al (2013) indicated that the most important determinants for lack of adoption and use of small-scale irrigation technology include access to ground and surface water, annual availability of water, gender of household head, level of education, access to credit and number of adult family members.

Nata and Bheema (2010), in their study of Hayelom watershed, revealed that the beneficiaries of hand-dug wells produce various vegetables, both for household consumption and (mainly) for sale. The dominant vegetable produced for market is onion, followed by green pepper and tomato, and farmers in the area can only sell their product in the local market or in the nearby towns, e.g. Hawzien. Their product is transported by human or animals, and, after travelling long distances, their products realize very little in the market. In addition, irrigation practices add to the problem; the majority of farmers are not market oriented, with many of them producing the same crop, e.g. onions. As a result, they face market problems, with a glut of onions bringing down prices. Also, according to Mintesinot et al. (2004), cited in Nata and Bheema (2010), creating better access to markets, especially for perishable and high value crops, might encourage farmers to cultivate more crops, and a greater variety, to increase their income.

Apart from marketing factors, water scarcity is a major limitation in the area. Especially during the scarcity of rainfall, the amount of water renewals low, thus the potential of wells providing water for irrigation purpose becomes limited particularly - during February to mid of May -

according to the respondents. Besides, the community is also less aware on ways of water utilization and management (Nata and Bheema, 2010).

2.8. Extension service in the world

Extension service is defined as a service of information, knowledge and skill development to enhance adoption of improved agricultural technologies and facilitation of linkages with other institutional support services (input supply, output marketing and credit) (World Bank, 2003, 3).

The evaluation of extension service effectiveness can be based on the relationship between extension activities and changes in farmers awareness' and knowledge of technologies, basically, the skills with which they can use the technologies, and the extent of adoption of those technologies, and farmers' access to information on complementary institutional support services e.g. markets, credit and input supply, and additionally farm productivity and efficiency. Therefore the efficiency of the extension service is measured by the level of cost with which these services are provided to farmers according to (Jumaboev et al, 2011*)*.

In the world wide , there are many problems which is affecting the agricultural extension service in many ways, those are chiefly; complexities involved in the service; the critical role of other institutional support services such as input supply, credit and agricultural marketing; lack of political support and commitment; and insufficient appropriate and relevant technologies; as the effectiveness and efficiency of extension service is contingent upon those overall policy environment for agricultural development. Lack of political commitment, this is mainly stand from urban bias and poor understanding of the role of rural development in the overall economic development effort of a country, has been another common problem confronting the extension service in many developing countries (world Bank,2004).

To address those numerous problems of extension service several promising approach had been done such as institutional arrangements, including improvements in extension management, decentralization, and community-focused approach, fee-for-service public provision, empowerment and participatory approaches, privatization, service contracting, and inter-connecting rural people and use of appropriate media based on Van den ban and Hawkins notion

(1996),cited in Berhanu et al. (2006).In general in the world wide, to alleviate problems of extension service and to improve the contributions of the success factors, the agricultural extension service is experiencing a number of changes.

There are five main goals which extension system should encompass, According to (world Bank, 2003) those are chiefly Transferring knowledge from researchers to farmers, Advising farmers in their decision making, Educating farmers to be able to make similar decisions in the future and Enabling farmers to clarify their own goals and possibilities while the last one is Stimulating desirable agricultural development.

2.8.1. Extension service in Ethiopia

Berhanu et al. (2006) demonstrated that as the speed of agricultural growth depend in the speed of current subsistence oriented production system is transferred into market oriented production system in Ethiopia, the agricultural extension service have a key role. Since it contributes to the development of the skill and knowledge of farmers to adopt and utilize new and improved technologies and animal, and the approaches and processes with which the skill development and access to information are realized.

Until about 2002 the focus of Extension services in Ethiopia were on increasing production and productivity in view of achieving food security. Nevertheless, it had become noticeable that without amalgamating farmers into the market, sustained growth in the agriculture sector would not be realized. Possibly as a result, the government policy on agricultural development has recently started to emphasize the transformation of subsistence agriculture into market orientation as a basis for long-term development of the agricultural sector (Mathewos and Chandargi 2005) cited in Berhanu et al. (2006).

It is clear that when farmers produce primarily for the market, quality and standard of the produce become much more important than during subsistence production, because competitiveness depends partially on quality of produce. In this fashion, Changing market conditions and consumer preferences require rapid adjustments in production technologies, and

timely and effective transmission of market based information. Technologies play critical role in market oriented production chiefly technologies which can save water as water is becoming scarce in elsewhere. Consequently the role of extension services should have to play a critical role in linking the different public and private stakeholders involved in input–output marketing and credit supply for the development of agricultural extension services according to (Belay, 2007).

To enhance the extension service it is not only the mandate of governments rather NGOs should have their role in providing extension services to farmers, mostly in more drought prone and food insecure areas. Some of the extension services provided by the NGOs use innovative extension approaches (IFPRI, 2010).

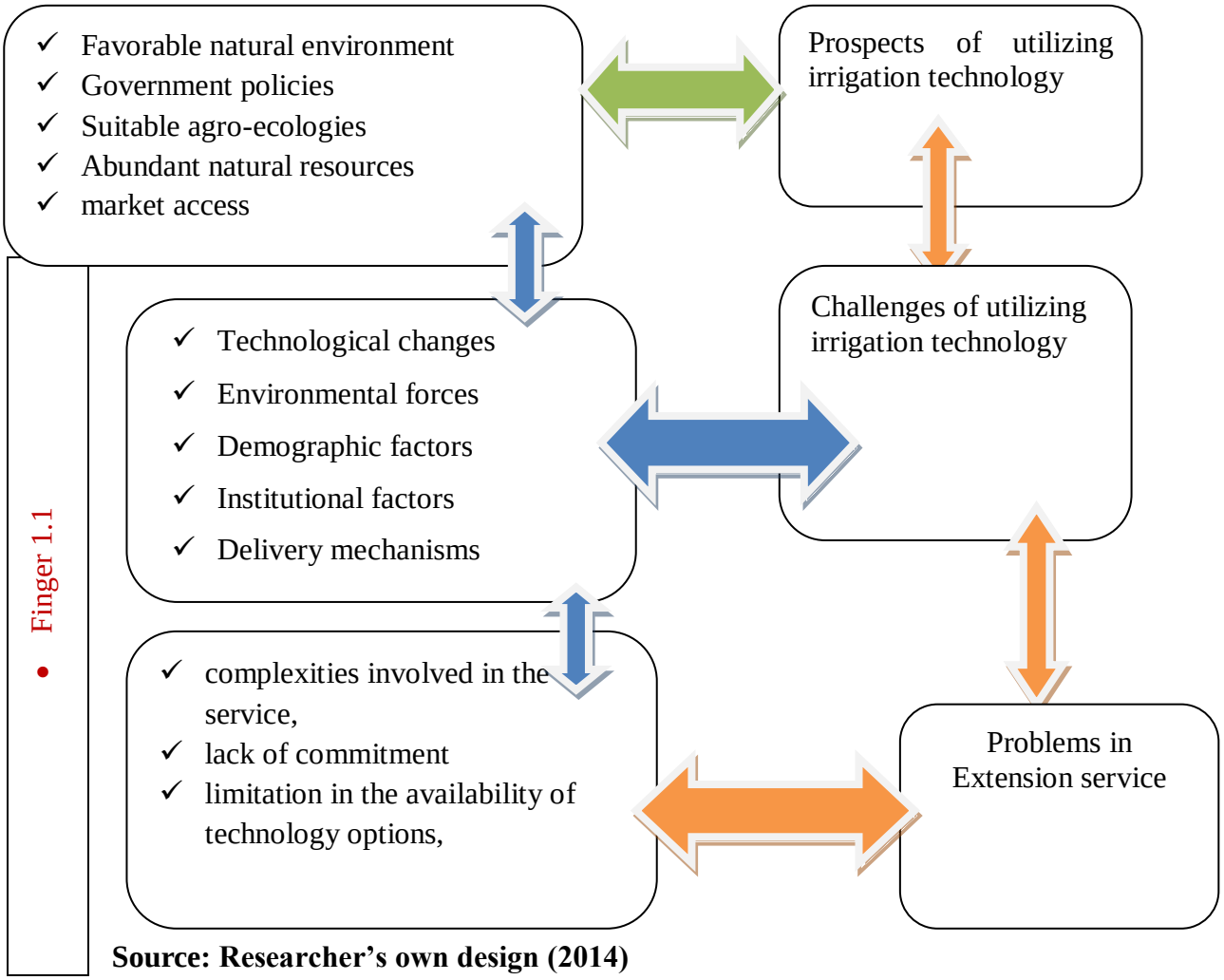
Farmers training centers have a critical role Currently Ethiopia. Accordingly the Ethiopian government is focusing in the Future extension services in the country are planned to centre on the use of farmer training centres (FTCs). It is planned to establish a numerous FTCs throughout the country. This is about one FTC at each 'kebeles'. Thus, almost every woreda in the country has started to construct FTCs. Some woredas have already constructed the required number of FTCs. The FTCs are constructed with participation of the farmers. In this way the FTCs are expected to provide as; centres of extension service and information as well as places where modular training to farmers for up to six months are given (Belay, 2007).

Even though there are some promising efforts that are being done by government of Ethiopia and NGOs there are also some basic problems that are affecting the development of extension service in Ethiopia. Those are basically; limitation in the availability of technology options, Top–down approach DAs and farmers, between the woreda and the regional level offices. The service is mostly supply driven not as such participatory way. Many technologies are prepared based on the available improved technologies and attempts are made to transfer to farmers. Hence, this supply driven approach of extension had been a common characteristic of all the extension service programs in the country. Therefore it should be in need to refocus the extension service to make it more demand driven and based on community resources. Since indigenous knowledge of farmers can have a great role and can be also be used as source of improved technology options (IFPRI, 2010)

Figure 1Conceptual Framework of the Study

A conceptual framework is important, for illustration purposes, when giving the study a context and rationale. It demonstrates the importance of the study by defining the main ideas and the network of relationships between them (Becker, 1998). It also grounds the study in the relevant knowledge bases that lay the foundation for the importance of the problem statement and research questions; it is intended to help researchers define the concept, map the research conceptual scope, systematize relations among concepts, and identify gaps in literature. For this study the following conceptual framework is developed based on the objectives and variables that are used as follow

Figure 2.1: Conceptual frame work for Challenges and prospects of utilizing irrigation



Source: Researcher's own design (2014)

CHAPTER THREE

RESEARCH DESEIGN AND METHEDOLOGY

This chapter presents about description of the study area, site selection, data types and sources, research strategy and design, data collection procedures, data collection tools, data processing procedures and data analysis.

3.1. Description of the study area/location

3.1.1. Figure 3Location

Figure 3.1: Woreda Ganta-Afeshum

According to the 2012 annual report of the woreda, Ganta-Afeshum woreda is located at 120 kms (approx.) north of Mekelle; it borders Saesi-Tsaedaemba woreda on the west, Ahifarom and woreda Warelikea in the east, Saesi-Tsaedaemba and Hawezain in the north and Gulamikada woredas in the south.

3.1.2. Topography and Climate

The area of the woreda is entirely rugged mountains, high plateaus and deep valleys. The woreda has an altitude ranging between 1900 and 3000m above sea level, and climatic conditions differ according to latitudinal variations. Due to the geographical and geological structure the agro-ecology of the woreda is Dega, W/Dega and kola in nature. The woredas highest rainfall occurs in summer season (keremt) and annually Amounts to 450-650 mm approx. (ABWGA, 2012).

3.1.3. Demography and population

The majority of the population of the district is rural dwellers, and they depend on crop production and livestock rearing to support their livelihood. The total population of the woreda, according to the annual reports (2011 and 2012), is 100,000 approx., with an annual growth rate of 2.5%. The total number of household heads is 21,644 approx; of this 12,311 are males and 9,333 are females; from the total households, 8,496 are the beneficiaries of irrigation. The woreda consists of 20 "kabeles" and 73 villages. With an area of 1,636.36 square kilometers, Ganta-Afeshum has a population density of 54.17, which is less than the Zone average of 56.93 persons per square km (Ibid).

3.1.4 Agriculture, Land, Natural Resources and Irrigation

The availability of land is an essential factor in farm production and rural family food security, along with accessibility and having a land holding of adequate size. Throughout the region, farms are fragmented, small in size and scattered, according to OARD (2011), and the total arable land in the district is 11,136.22 hectares approx. The soil type is 50% sandy, 35% loam and 15 % black soil. The major crops cultivated in the woreda include barley, wheat, maize, sorghum and teff – the local tiny grain used in the production of injera, which is an important part of the staple diet throughout Ethiopia

A sample enumeration performed by the CSA in 2001, cited in a District Agricultural Office's report (2012), interviewed 20,704 farmers in this woreda, who held an average of 0.37 hectares of land per head of the 7,710 hectares of private land surveyed.

Table 3.1: Land use (cover of Ganta-Afeshum 'wereda')

Type of land	Area (hectare)Percentage
under cultivation	83.38
woodland	2.67
Pasture	5.15
Fallow	1.95
Land devoted for other uses	6.85

Source: District Agricultural Offices

Of the land under cultivation in this woreda, 64% was planted in cereals, 8.9% in pulses, 0.61% in oilseeds, and 13 hectares in vegetables. The total area planted in fruit trees was 646 hectares, while 78 hectares were planted in gesho. 72.00% of the farmers raised both crops and livestock, while 25.63% grew crops only and 2.37% raised livestock only. Land tenure in this woreda is 94.88% owning their land, 3.39% renting, and 1.74% holding their land under other forms of tenure (Ibid).

In the past two years (2012&13) more than 1,006 new irrigation technologies were adopted and over 13,576 people participated; of this 1,256 were deemed to be young farmers, according to year book of the woreda (ARoWGA, 2012).

3.2. Site Selection

Ganta-Afeshum Woreda was chosen deliberately; this was due to the revelation in the annual report of Ganta-Afeshum 'Wareda' (2013) that, even though there is an attempt at supplying different modern water-saving irrigation technologies, e.g. drip and treadle pumps by woreda and NGOs, e.g. ADCS, farmers are not utilizing the systems fully; thus, many supplied modern irrigation technologies are defunct. Accordingly, this researcher was motivated to investigate the prospects and challenges hindering the utilization of irrigation technology in this area.

3.3. Data Type and Source

The study had been used both primary and secondary data. Primary data was collected using the survey method, with the help of a standard questionnaire designed to obtain information from selected sample households. The questionnaire addressed issues related to socio-economic, organizational and institutional challenges of the users, prospects of using irrigation technologies, follow-up conditions for DAs and demographic information. Furthermore, the researcher had discussions with key informants and focus groups. The leading question prepared to guide the discussions with the focus group and key informants was put emphasis on major problems and prospects of utilizing irrigation technologies. Personal observation was also employed, and careful records were kept throughout. While secondary data was data about challenges and prospects of irrigation technology utilization from different publications.

Information was gathered both from primary and secondary sources. The primary sources were farmers, key informants from "woreda" administration, from Adigrat Catholic Church and extension personnel as well as focus group. While documents, international publications about utilization of irrigation technologies and websites were served as secondary sources for the secondary data source.

3.4. Research Strategy and Design

Since the primary concern of this study was to assess the Challenges and Prospects of utilizing Irrigation Technologies, both qualitative and quantitative approaches had been employed. The combination of qualitative and quantitative techniques can help the researcher to cross-check /triangulate the relevance and accuracy of the data. Both approaches had been employed towards meeting all research objectives. An appropriate survey was designed, and this research design was enabled the researcher to effectively administer and manage the tasks when the data collection takes place. It was a very important method, as data was gathered from the sample of respondents, and the researcher was described the concepts regarding the challenges and prospects of utilizing irrigation technologies in the selected 'kabeles' of the woreda.

Furthermore, the research was cross-sectional, since the study was conducted in a small portion of the population sampled at a point in time.

3.4.1 Target population and sampling

3.4.1.1. Target population

The target population of the study was households in Ganta-Afeshum "woreda" who use irrigation technology. According to the annual report of Agriculture and Rural Development office of Ganta-Afeshum 'woreda' (2012) the number of farmers who adopted new irrigation technologies in four 'kebeles' are 309. Accordingly, the sample size was determined from the total number of adopters of these four "kebeles". In addition to this, the researcher was used ten key informants from "woreda" a demonstratives, ADCS, extension personnel and farmers.

3.4.2.1. Determining sample size

Identifying and determining the sample size from the total target population is a main task in research design. Yamane, (1967, cited in Caroline and Moses, 2013) provides an easy formula for determining sample sizes, and this researcher had prioritized the method due to its simplicity.

n= N/

1+N (e) 2

Where

n=sample size

N=Total population

e =acceptable error

N=309

e=0.05 Thus n=309/1+309(0.05)2

n=174

The researcher believes it is necessary to use an independent sample for each 'kebele' to ensure equal representation. However, the selected 'kebeles' have different numbers of Irrigation Technology adopters; therefore, the sample size for each 'kebele's was calculated proportionately. The researcher was used 'proportionate sample allocation' in an attempt to make each stratum sampled identical with proportion of population. Therefore, the proportional sample size from each stratum was calculated by using the following formula:

$$ni = nxNi/N$$

Where:

ni= sample size for individual 'kebeles'

Ni= the total number of irrigation technology adopters in each 'kebele'

N=the total number sample size

n= the total sample size for selected 'kebeles'

In view of that, the table below shows the proportionate sampling for each 'kebele' based on the formula given above.

Table3.2. Proportionate sample for each 'kebele'

'Kebeles' of Ganta-Afeshum 'Woreda'	Total adaptors of New Irrigation Technology.	NO. Sample Size	Type of sampling which used
SasunBteHariyat	138	78	Simple random sampling
DiblaSihet	100	56	Simple random sampling
Baati May Mesanu	36	20	Simple random sampling
Bukat	35	20	Simple random sampling
Total	309	174	Simple random sampling

Source; Data from ARDO of 'woreda' Ganta-Afeshum and researcher's composition, 2013

By taking the above table into consideration, the researcher was selected only 174 respondents from the total members of adaptors of New Irrigation Technology using proportional methods. Having selected such a number of respondents, the questionnaires was distributed by using

Simple Random Sampling Technique to select respondents from each 'kebeles' as indicated in the above table. As a list of adopters of new irrigation technology already exists in each 'kebele', this sampling method enabled the researcher to easily administer the data collection process from the selected respondents.

3.5. Data collection procedures

Ganta-Afeshum 'Woreda' has 20 'Kabeles' and the researcher selected four 'Kabeles' deliberately, as, in those 'kabeles', both Governmental& NGOs initiate and supply various water harvesting irrigation technologies, but many farmers had failed to utilize them. Furthermore, those 'Kabeles' were principally adopters of Irrigation Technologies (ARDO, 2013). The sampling frame being the total number of adopters of Irrigation Technologies in four 'kabeles', the respondents were selected using Simple Random Sampling (Lottery) Method from four 'Kabeles' in order to give equal chance for all in the Sampling Frame. Four enumerators were engaged in administering questionnaires and they were trained for two days before they start. Then, 30 questionnaires were used for pre-testing, to assess the clarity of questions, consistency, language appropriateness, flow and sequencing of questions, length of time, and ethical considerations. After that, on the basis of the results obtained, the questionnaire was managed in the selected 'kabeles' at the convenience of respondents. The researcher himself was involved, as supervisor, throughout the questionnaire administration process.

3.6. Data collection tools

Data was collected from the sample group through questionnaires, interviews, focus group discussions and observation. To supplement and enhance the information presented, Secondary data was accessed from both published and unpublished articles. The main sources of information was gathered through the questionnaire, from the farmers of four 'kebeles', key informants and focus group discussions from woreda administrative body, ADCS, extension personnel and farmers in line with observation .

Questionnaire: The questionnaire was designed by the researcher himself, and administered by enumerators in the four 'Kabeles' of the 'woreda'. The questionnaire was prepared in the

English language, so that enumerators were simply understood the content since they were educated and translated for the respondent farmers by Tigrigna language. The questionnaire was designed to include questions on the following, the factors that influence irrigation technology utilization by farmers, existing opportunities to use irrigation technologies, ways of supervising system usage by extension workers for utilisation of irrigation technologies,ways of improving utilization of irrigation technologies in 'Ganta-Afeshum' Woreda, and demographic questions at the introductory part of the questioner. Questions were both structured and semi–structured, to elicit accurate information. The questionnaire was distributed to and used with the 174 farmers at the convenience of them.

Key Informants Interview: In addition to other data gathering techniques, the researcher had interview with key informants in a face-to-face fashion, in order to elicit the maximum information. Scheduled to be convenient for interviewees, interviews of a semi-structured type was carried out by the researcher himself, with key informants chosen based on knowledge of the problems in the study area in utilization of irrigation technologies. To meet this goal, the informants for the researcher were extension personnel working for four kabeles, 'woreda' Administrative staff in charge of Agriculture and Rural Development, woreda heads of Water Resources, mines and Energy Development, Department of Irrigation Extension Services, and farmers from four 'kabeles'.

Observation: The researcher devoted adequate time to observation of the 'woreda's community and its work. He was evaluated what the farmers really did in utilizing technologies, particularly the functionality of irrigation technologies, organizational design systems, access to water for irrigation, condition of access to spare parts for irrigation technology, condition of distribution structures, the total area proposed for irrigation practices, type of crops grown and other relevant data was observed in the field, and photographs had been taken for illustration purposes. This was done after the questionnaires were collected. In this study, therefore, an attempt was made to observe and understand every situation, and for the research to be free of bias.

Focus Group Discussion: Firstly, the researcher had taken 12 people to discuss the research questions prepared by the researcher himself. There were two focus-group discussions with carefully selected people with knowledge of the area. The discussions was arranged at times to suit those selected, and they were given ample notice of time and location, with the importance of attendance emphasized. The researcher was chaired and facilitated the discussions, and recorded the deliberations in audio format – for later interpretation and documentation.

3.7. Data Processing and Analysis

After careful collection of data, both from primary and secondary sources, it was checked for reliability. Thus, data was summarized and rearranged and then converted to descriptive format for analysis. The analysis of qualitative data was both during and after data collection. Then, Statistical Package for Social Sciences (SPSS version, 16.0) software was used for the cleaning and structuring of data. Finally, the outputs of the statistical arrangements were analyzed using tables and pictures, to provide evidence and to support the qualitative information etc. Data collected through interviews and focus-group discussions were also incorporated into the qualitative results, and it was described and analyzed with clarity. The Conclusions and Recommendations in this study were arrived at carefully, and were based on data and information gathered during the research.

This type of data processing and analysis system has been used by many researchers who conducted studies on irrigation, e.g. Yalew, (2010) and Haile (2009), who used the descriptive analysis method using the Statistical Package for Social Science (SPSS).

CHAPTER FOUR

DATA PRESENTATION AND DISCUSSION

This chapter presents the survey results, discussion and analysis of data collected through primary sources and secondary sources such as questionnaires, interviews, focus group discussions, observation and different publications on the challenges and prospects of utilization of irrigation technologies.

4. Demographic Characteristics of the Respondents

4.1.1. Age Composition

It is clear that family labour– people of all ages - is a very important resource for small farms. In this regard, age of farmers is one of the main and distinct factors that can influence modern irrigation technology utilization, either positively or negatively. While those aged fewer than 12 and over 60 have been omitted from the matter under consideration here that does not mean that their contribution is not valued. Accordingly, the following table demonstrates the age group of respondent farmers.

Table 4.1: Age Composition of the Respondents

		Count	Column N %
Age composition of the respondent	18-33	9	5.2
	34-49	67	38.5
	50-64	61	35.1
	More than 65	37	21.3
	Total	174	100

Source: Field survey; 2014

Table 4.1 shows that the majority of respondents (38.5%) were found under the age composition of 34-49. Therefore, we can understand that the age group which is selected by majority of respondents is the age which can be good for the utilization of new irrigation technologies,

because in this age composition farmers have a full power to practice technologies and do not exposed to uncertainties about new technologies.

Concerning this issue, authors' like Regassa et al, (2005), Odoemenem and Obinne (2010), argued that the age group which the majority of respondent farmers selected is the best age composition for adoption and utilization of modern irrigation technology. They also argued that when the age of the farmers increases, the desire to adopt and use the new technologies decreases; this is thought to be due to the fear of taking risks, e.g. financial, reliance on available labour, to implement those technologies..

4.1.2. Educational Status

The educational level/status of farmers is another important factor to be considered acceptance and usage of modern irrigation technologies, as indicated by Liberio (2012). Those who are educated (both formally and through extension courses) have a higher interest than those who are not educated, in adopting and utilizing new irrigation technologies. The following table shows the educational level of respondent farmers.

Table 4.2:Education Level

		Count	Column N %
Education level	Illiterate	84	48.3
	Read and Write only	46	26.4
	Elementary	25	14.4
	High school completed	19	10.9
	Diploma and above	0	.0
	Total	174	100

Source: Field survey; 2014

Table 4.2 shows that the biggest single group, 48.3% of respondents, are those whose are not educated to a standard of functional literacy.

Regarding this issue, during the focus group discussion many attendants revealed that, an adoption and utilization of a new technology, such as irrigation, is a complex event. Because of

Several factors contribute to make decisions affecting adoption and utilization. From many factors which are influencing the farmer's decision is 'attitude' towards new irrigation technologies mainly drip irrigation technologies. Therefore this negative perception is contributing for low utilization of new irrigation technologies and these negative attitudes is instigated from lack of education and clear know how about the use and reward of new irrigation inputs. Standing from this point of view, we can conclude that utilization of new irrigation technologies are very small in the survey area because of the lack of education that the potential farmers have.

Pertaining to this issue, there were similar findings by Farah & Bahaman (2013) in their study 'Factors Impinging on Farmers' Use of Agricultural Technology in Malaysia' and they concluded that farmers' perceptions, levels of education and knowledge are all factors affecting adoption and utilization of new irrigation technologies.

4.2. Prospects of Utilizing Irrigation Technologies

In the study area, Even though there are many challenges to the introduction and utilization/implementation of new irrigation technologies that will be seen in next part of this study, there are some encouraging aspects. Hence, the next part of this study considers the main points as indicated by the respondent farmers as important towards the increased exploitation of the new irrigation technologies in the study area.

4.2.1. Magnitude of Labor force Participation in Irrigation

Respondents felt that labour size, i.e. having enough labourers to carry out the various tasks in modern irrigation, is a very important factor in its exploit. According to respondents and discussions with focus groups, having several family members to share the irrigation tasks makes it more likely that the technology is used efficiently and effectively. The subsequent table will demonstrate what the respondents' response concerning this issue.

Table 4.3: Categories of labour Size

		Count	Column N %
How do you categorize your labor size which can participate in irrigation?	Small	32	18.4
	Enough	126	72.4
	Large	13	7.5
	Excessive	3	1.7
	Total	174	100

Source: Field survey; 2014

Table 4.3 demonstrates that the majority of respondents (72.4%) have enough labour force to practice new irrigation technologies. As family labour is vital for the practice of new irrigation technologies farmers in the study area putted as great opportunity. Furthermore, farmers were asked about the impact of having a labour of adequate size, and they were very positive with their replies; while they recognized that all technology use was not the same, to have the resource of labour to hand meant that the technology use was far more likely to succeed. Moreover, the researcher had an interview concerning this issue with one male household head in 'Kebele' Debla -Seat, during which he said:

> *"…….I have enough family members……, five members are students……and the rest five are not, this much of labour that I have is enough and very effective in practice of irrigation…… They help me a lot during the preparation, planting, harvesting and also in watering time….but when I observe some of my neighbors who have a little family members…. they have a big problem in doing those all operations during irrigation time…..but I mean not that all time having many family members is effective enough in irrigation practice other than in general……"*

Accordingly, it is simple to conclude that the majority of respondent farmers feel that their labour is of adequate size to put modern irrigation into use; this indicates that farmers have no problems regarding the amount of family labour available to them.

But contrary to the above conclusion, Adeoti (2009) and Takeshima (2011) concluded that labour is not a factor in success as once the labour force increases the adoption and use of new technologies inversely decreases because rather than using new technologies they tend to use the labor that they have in practice of irrigation. On the other hand, like the present study, Abadi and Tesfaye (2006) and DFID (2007) felt that the availability of the labour increased both the interest in, and use by, farmers of the new technologies.

4.2.2. Agro-Ecological Zone:

As presented earlier, Ethiopia is gifted in predominant presence of diverse and suitable agro ecologies for production of many crops and abundant natural resources, there for these plentiful possessions have seen as a very promising prospects for the development and practice of new irrigation technologies. Having said this, let us see now, what the condition of agro-ecological zone look like in the study area according to the respondents from the subsequent table.

Table 4.4: Condition of Agro Ecological Zone

		Count	Column N %
Do you think that your agro-ecological zone is conducive to produce different crops using new irrigation technologies?	Yes	140	80.5
	No	34	19.5
	Total	174	100

Source: Field survey; 2014

The above table shows that of the 174 respondents, 140 (80.5%) felt that their Agro-ecological zone is very conducive to produce crops using new irrigation technologies whereas fewer respondents displayed that their agro-ecological zone is not conducive to produce crops using new irrigation technologies. Pertaining to this issue, the attendants of focus group discussions notified that there are favorable conditions such as the soil, climatic condition and high land productivity. Concerning the soil, attendants revealed that the soil that they have in their plot of farm land is good enough to produce more production using water lifting technologies of

irrigation and also there is a good climatic condition which is mostly W/Dega and Dega in nature. In conclusion, standing from the prior discussions from respondents and attendants of focus group discussions we can put that the agro ecology zone of the study area is conducive enough to produce different crops via using of new irrigation technologies and this can be seen as the prospect for utilization of new irrigation technologies in the study area.

Similar to the survey study DFID (2007) revealed that the existence of a favorable natural environment and suitable agro-ecologies had been identified as major contributors towards increased use of modern irrigation technologies in Ethiopia.

4.2.3. Access to Money

In this study, farmers were asked about the availability of money, from their own savings or from other sources, to buy spare parts for broken irrigation equipment. The following table gives a summary of their replies:

Table 4.5: Access to Money

		Count	Column N %
Do you have money to buy spare parts to maintain your irrigation equipment?	Yes	108	62.1
	No	66	37.9
	Total	174	100

Source: Field survey; 2014

More than half of the respondent farmers (62.1%) have no problem concerning money to buy spare parts for broken irrigation equipment; In addition to that, during the focus group discussions, farmers attending verified that they have access to credit from co-operatives, micro-finances and other sources, which they acknowledges as contributing to their successful use of the new irrigation technologies. We can conclude, therefore, that such access to finance is a major enhancing feature in the drive towards wider use of modern irrigation technology in the study area.

4.2.4. Access to Market

The next question was on access to markets. On this topic, David S and David Z (2000) had a large amount of empirical evidence on the geographic concentration of new technologies; geographic patterns of technology adoption and practice may be linked to considerations of marketing and product support efforts.

Those researchers found that the new technologies are likely to be adopted and used earlier near market centers, where sellers and product supports are easily available. In the same way, if the farmers are motivated by access to markets – giving them assured profits - they are inspired to utilize the new technologies. The following table summarizes the information gathered in this study:

Table 4.6: Access to Market

		Count	Column N %
Do you have market access for your produce?	Yes	174	100
	No	0	.0
	Total	174	100

Source: Field survey; 2014

As indicated in the above table, 4.6, all respondents (100%) have access to markets for their produce but there is no any respondent who have no market access for his/her produce. Through the focus group discussion sit emerged that farmers have access to markets in their own 'kebeles' and in the town like Adigrat; they also have access to transport for themselves and their produce, and this is seen as a motivator towards employ of modern irrigation technologies. Since, they have the market access for their produce they will have no any uncertainty about their produce from perishables and where they sell. From this point of view it is simple to wind up; access of market is one of the inspiring features for the utilization of new irrigation technologies in the Survey area.

4.2.5. Support by Government and NGOs

The next question raised with the respondent farmers was the level and value of support for farmers by government and NGOs regarding irrigation development. Concerning this issue, a key informant from the office of agriculture and rural development felt that, our government is striving to enhance agriculture - the leading sector in our country's economy. In doing so, promoting new irrigation technology utilization have a vital role. Accordingly, the local government (woreda) is practicing many alternative ways, e.g. mobilization of farmers by means of organizing them into unions, expansion of the practice of extracting ground water for irrigation purposes, and deployment of irrigation experts to help farmers, towards spreading and increasing the impact of irrigation.

Similarly, during the focus group discussions, many farmers said that, even though there are many problems concerning irrigation technologies which will be seen in next part of this study, the efforts of the government and NGOs are inspiring them to focus on the strategies and to effectively utilize the new irrigation technologies that they possess. The following table sheds light on the replies.

Table 4.7: Support of Government and NGOs towards use of new Irrigation Technologies

		Count	Column N %
How do you evaluate the support of government and NGOs to practice your irrigation with new Its?	Very satisfactory	2	1.1
	Satisfactory	108	62.1
	Unsatisfactory	64	36.8
	Very poor	0	.0
	Total	174	100

Source: Field survey; 2014

From table 4.6 we can see that nearly two-thirds of respondents (62.1%) are satisfied with the support of government and NGOs. According to key informants from the ADCS food security project, they are providing advice and support on various modern irrigation technologies for the farmers, e.g. access to credit sources, the excavation of water tanks and diversion of water

streams. The following picture illustrates the type of project promoted and supported in the study area by REST.

Figure .4.1. River Diversion Work, in 'kebele' Debla-Seat by REST

Source: field survey; 2014

As we can see in the preceding picture, the river water is to be diverted towards a non-irrigated plot of land by REST. When construction of the dam is finished, access to water supply will be increased, and the nearby farmers who have irrigation technologies will be enabled to utilize their technology to support better crop production, according to the key informant from 'Kebele' Debla-Seat. This project was fully discussed with the focus group, who acknowledged the many ways in which both government and NGOs are supporting the farmers. In conclusion, the support of government and NGOs in the study area was identified as the grand opportunity that is inspiring farmers to utilize new irrigation technologies effectively.

This is borne out by the study of Awulachew, S. B (2007), who concluded similarly regarding the positive effects of the supports available to farmers in design, planning and implementation of new irrigation technology.

4.3. Challenges in Utilizing Irrigation Technology

So far we have seen about the main prospects which can mount the utilization of new irrigation technologies in the study area based on the survey results. While this part of the study reflect on the main challenges hindering utilization of modern irrigation technologies in the study area. But first we must look at what kind of technologies the farmers own since this gives insight about which technology is widely adopted in the survey area.

4.3.1. Types of Modern Irrigation Technologies

The following table shows which new irrigation technologies were adopted by farmers in the study area.

Table 4.8: Types of Modern Irrigation Technologies Adopted

		Count	Column N %
What type of new irrigation technologies do you have?	Drip	43	24.7
	Pressurized treadle pump	20	11.5
	Motor pump	107	61.5
	Row pump	0	.0
	Foot pump	4	2.3
	Total	174	100

Source: Field survey; 2014

As seen in the table 4.8, many respondent farmers (61.5%) have motor pump irrigation technology but miserably no respondent adopt a row pump irrigation technology. In addition to that during the focus group discussions, the general feeling of farmers was that with their access to ground water, the preferred technology was that using motor pumps. Since motor pumps are conducive for the areas which have no surface water and mainly depend on ground water. In general, the leading irrigation technology which is adopted by the farmers in the study area is motor pump.

4.3.2. Challenges in Maintaining Irrigation Technologies

In the hope of eliciting views on what were the challenges to using modern irrigation technology, farmers in the study area were asked about maintenance of irrigation equipment used. Farmers confirmed that the new technologies they use are not easy to maintain, mainly due to lack of knowledge and skills, and their responses are summarized in the table below.

Table 4.9: Simplicity of New Irrigation Technologies

		Count	Column N %
Is the irrigation technology you use simple to maintain?	Yes	10	5.7
	No	164	94.3
	Total	174	100

Source: Field survey; 2014

94.3% responded, with regret, that new irrigation technologies are not simple to maintain, but the only small number of the respondent farmers revealed that the technology which they owned is simple to maintain. In addition to the majority of respondents reply above, key informant from four 'kabeles' demonstrated that even if they accept the new irrigation technologies they have difficulty in preserving it; because most of new irrigation technologies such as drip, motor pump and Pressurized treadle pump are complicated to maintain during the broken time/when it becomes non-functional and as lack of knowledge and skills. The same to that of the key informants' reaction the focus group attendants also acknowledged the problem that they have concerning the simplicity of new irrigation technologies in preservation time.

Standing from the above inspection, we can conclude that majority of farmers in the study area have a difficulty to maintain new irrigation technologies due to its complexity and shortage of knowhow and skill.

Likewise, the study entitled 'Social, Economic and Institutional Factors Affecting Utilization of Rain water Harvesting Technology, in Eastern Tigray', by Abadi and Tesfaye (2006),with a sample of 201 households, indicated that skill and knowledge were found to be highly important variables influencing utilization of irrigation technologies

4.3.3. Access to Spare Parts for Irrigation Equipment

Recognizing that all technology breaks down sooner or later, access to spare parts is an important variable. This can positively or negatively affect the utilization of new irrigation technologies. The following photographs give an indication of what is likely to happen when equipment breaks down and the farmer lacks knowledge, skills and/or access to the spare parts which may be required to carry out repairs. In essence, the broken or damaged material lies idle, often rusting or decaying.

Figure 4.2: Broken modern irrigation technology at home

Source; field survey; 2014

So, farmers may have the will and interest, access to markets, and enough labour to produce crops, but their irrigation equipment often lies idle due to lack of spare parts and the knowledge and skills to carry out the necessary repairs. Concerning to this issue it emerged in the group discussions that the necessary parts are not available even in the regional capital city, Mekelle hence they forced to put at home or ealse where.Thus, lack of extra parts available nearby is identified as a main challenge hindering development of advanced irrigation technologies.

This finding is consistent with that found in many other studies, e.g. David S and David Z (2000), Takeshima et al (2010), Tiamiya (2009) and Bagheri and Ghorbani (2010). Furthermore, the study conducted in Tigray region by Nata and Bheema (2010) revealed that, while irrigation

technology utilization is considered as an advantage, spare part provision was found as a major challenge.

4.3.4. Access to Water for Irrigation Technology Use

As water is singled out as an obvious and critical variable in the use of irrigation technology, farmers were asked about the availability of water in their area, so that they could use irrigation technologies. The same issue was addressed in various studies, including Tadesse et al, (2013) and M.H. Ali (2010) and they disclosed that water source scarcity can be a major challenge to the utilization of irrigation technologies. Bearing this in mind, let us consider the responses of farmers in the current study:

Table 4.10; Condition of Water Access for Irrigation

		Count	Column N %
Do you have access to enough water for irrigation practice?	Yes	46	26.4
	No	128	73.6
	Total	174	100

Source: Field survey; 2014

Table 4.10 specifies that 73.6% of farmers asked regretted that they had not access to enough water for their irrigation practice. It is known that water is base for practice of irrigation but in the study area there is the problem of water access as we can see from the table. Considering this water scarcity as a main challenge to farmers, the researcher asked a key informant from Ganta-Afeshum Woreda Office of Water Resources, Mines and Energy about water source opportunities for the farmers to utilize new irrigation technologies. The response was that…

> *"As far as possible, we are doing our utmost in helping farmers to have their own water storage tanks and in teaching them about diverting streams for irrigation purposes: nevertheless, there are some problems still to be resolved".*

In the same way, in their study in Hayelom watershed, Nata and Bheem (2010) revealed that water scarcity is seen as a principal restriction in the basin. Particularly during the scarcity of

rainfall, the quantity of water recharge becomes low, thus the potential of wells supplying water for irrigation purpose becomes limited, particularly during February to mid-May. Also, the community lacks awareness on water use and management.

4.3.5 Income from Non-Crop Production Activities

It is obvious from talking to farmers in the study are that income generation from activates other than crop production is important to households, directly by helping in the family budget, and indirectly by influencing agricultural activities with possible implications for sustainability. Pressure on natural resources may be reduced when households have alternative sources of income.

Furthermore, investments in the resources, e.g. fertilizer, might be facilitated by cash income from non-farm activities. But, paradoxically, non-crop activities in the study area were felt to be a challenge when developing the utilization of irrigation technologies. Let us see the following table.

Table 4.11: Non-Crop Production Activities

		Count	Column N %
Do you derive income from activities other than crop production?	Yes	133	76.4
	No	41	23.6
	Total	174	100

Source: Field survey; 2014

As we can see from the table 4.11 a vast number of respondent farmers (76.4%) are engaged in non-crop production activities than irrigation. According to above data majority of farmers in the study area are engaged in non-crop activities than irrigation practice. During the focus group discussions farmers were open about their income generating activities outside crop production. Many of the responses referred to daily labour, security work, food for work, sale of local beverages, bee keeping, poultry, cattle, goat and sheep husbandry and selling produce at the market. Additionally, the researcher had an interview concerning this issue with one female household head in ‘Kebele’ Bati Ma-Masanu, during which she said:

> "….*I have drip irrigation technology and I used it for the past two years effectively; ……but later on it was broken….I was unable to repair and maintain it….I turned to bee keeping and honey production. After I started to use this option I got more income than what I was getting from irrigation… I made more than seven thousand birr annually from selling honey. .....So, this is a better option than practicing irrigation, and that is why I stopped trying to maintain and use irrigation technology….."*

The simple conclusion is that income generation through activities other than crop production is a challenge to the introduction, implementation and maintenance of modern irrigation technologies in the study area.

Similar findings were mentioned by Gyasi*et al* (2006), cited in Nhundu, k. and Mushunje, (2011)in their study in Ghana; they found that access to income from other sources was a dis-incentive, and militated against families' and communities' adoption and utilization of the modern irrigation technologies.

4.3.5. Summary of Challenges which can inhibit Irrigation Technologies Practices

The next table shows the factors which respondent farmers find to be the most important challenges to the use of modern irrigation technologies.

Table 4.12; Important factors that inhibit irrigation technologies utilization

		Count	Column N %
Rank the following important factors which most inhibit your irrigation technology utilization at present?	Lack of training	40	23
	Lack of inputs	13	7.5
	Shortage of labor	2	1.1
	Uncertainty about new Its	25	14.4
	Water scarcity	65	37.4
	Lack of marketing for produce	5	2.9
	Lack of know how	18	10.3
	Lack of finance	2	1.1
	Lack of skill	4	2.3
	Absence of Gov't support	0	.0
	Total	174	100

Source: Field survey; 2014

Table 4.12 confirms that water scarcity, lack of training and uncertainty about new irrigation technologies are deemed by respondent farmers to be the most important challenges to the introduction and spread of new irrigation technologies; after the first three, the next two are the lack of know-how and lack of inputs.

In focus group discussion farmers were asked about the general perception of new technologies. Many felt that they had a dilemma, and revealed their uncertainties about the use of modern irrigation technologies, especially about the feasibility of using drip feed irrigation.

The following image can just illustrate situation of the new irrigation technology in the study area.

Figure 4.3: Modern irrigation technology equipment, broken and cast aside, or put to other use.

Source: field survey; 2014

This picture helps us to reason that new irrigation technologies are not in usage in a very simple way rather farmers throw it here and there and also utilized it for the other purposes as we can view from picture five because of broke down of the new irrigation technologies. In general, many farmers are not utilizing the modern irrigation inputs, due to uncertainty and many other problems including the factors listed in the last table.

4.4. Follow-up by Experts to Utilization of Irrigation Technology by Farmers

It is clear that farmers require clear and updated information and know-how about new irrigation technologies in order to utilize them effectively. To this end, the situation concerning extension personnel is of crucial importance. Accordingly, Margarita et al (2013) disclosed that farmers should acquire enough awareness about the advantages and exploitation of any new farming technology, mainly through extension personnel (from either private, NGOs, or public extension agencies), and this is considered as one necessary condition while planning the establishment of modern agricultural systems.

Furthermore, Van Den Ban and Hawkins (1988) felt that agricultural extension work is a very important tool in rural development. The central aim of extension programmes should be to initiate change towards bringing about sound agricultural development, especially on the part of smallholder farmers. The study suggests that extension personnel would give technical advice and supply all other necessary inputs and services.

Therefore, this researcher was interested in what assurances there were for farmers in the study area about follow-up and support of extension personnel: hence the next portion of this topic. The following table shows that a majority of respondent farmers (95.4%) were visited by extension agents.

Table 4.13: Extension Contact

		Count	Column N %
Have you ever been visited by an extension agent?	Yes	166	95.4
	No	8	4.6
	Total	174	100

Source: Field survey; 2014

This implies that farmers have no problem with visit of extension agent. With regard to this issue (Odoemenem and Obinne, 2010) putted a very good rationalization about the visit of extension agents; adoption and utilization level increases with increase in the intensity of extension visit

and services offered to farmers. The constant meeting/frequency of extension contact between the extension personnel and the farmers would create better awareness for the potential gains of improved agricultural innovations and technologies

4.4.1. Frequency of Contact by Extension Personnel

The next concern was about frequency of contact. Hence farmers were rated according to their contact that they had with extension agents.

Table 4.14: frequency of contact

		Count	Column N %
How often are you visited by an extension agent?	Often	107	62.6
	Sometimes	55	32.2
	Rarely	9	5.3
	Total	171	100

Source: Field survey; 2014

Table 4.14, shows that 62.6% of respondent farmers were often visited by extension personnel and this shows that farmers have no great problem with extension contact. But, as raised in focus group discussions, the problem is not in quantity of visits, but quality; the aim of visiting extension agents seemed to be more often about promoting fertilizer use, access to credit and participation in political committees than educating farmers about modern irrigation technologies.

The extension personnel also complain that they have no clear job description; even though they are assigned as irrigation experts, they are allocated other duties, e.g. farm input distribution, collection of loans and taxes, and the promotion among farmers of the benefits of participation in various administrative and political committees. Accordingly, we may conclude, although majority of respondents visited by an extension agent often, farmers are not receiving the necessary information and training on irrigation technologies due to unclear job descriptions of agricultural extension personnel.

4.4.2.Timing of Visits by Extension Agents

It is clear that visits by agricultural extension workers are very important to farmers contemplating the installation and use of modern irrigation technologies. The following table shows that extension personnel visited farmers mostly during preparation time. However, farmers need information, advice and training during all stages, including, importantly, during implementation, use and in times of necessary maintenance. The following table demonstrates the timing of Visits by Extension Personnel.

Table 4.15: Timing of Visits by Extension Personnel

		Count	Column N %
During which operation were you visited by extension agents only about irrigation technologies?	Irrigation technology preparation times	116	67.8
	Planting/transplanting times	44	25.7
	Maintenance times	8	4.7
	Applying agro chemicals times	0	.0
	Watering times	3	1.8
	Harvesting times	0	.0
	Total	171	100

Source: Field survey; 2014

Table 4.15 shows that the enormous numbers of respondents (67.8%) were visited during the first irrigation technology preparation time. From this table we can understand that farmers are visited by extension personnel's only during the time of irrigation technology preparation but Farmers should visited in every stage of operations in order to get information about how to use those new irrigation technologies if this is not happened they may tend to not use it. From the above table we can see that farmers were vested during the first irrigation technology preparation times and of course, this cannot bring change in utilization.

Therefore, from the above statistics we can understand that farmers are not getting extension service during the implementation of new irrigation technologies in all stage of operation.

Regarding this situation, Margarita et al (2013) stated frankly that farmers should acquire adequate information and awareness about any new farming technology mainly through extension personnel and at different stages of operation/implementation.

4.4.3. Training on the Operation and Maintenance of the New Irrigation Technologies

This part of the discussion is about the frequency and timing of relevant training for farmers. The following table illustrates access training for farmers in the study area to training:

Table 4.16: Training on Operation and Maintenance

		Count	Column N %
How many times did you get training about ITs?	Once per irrigation season	0	.0
	Once per year	14	14.1
	As required by the community	2	2.0
	As planned by the Government and NGOs	83	83.8
	Total	99	100

Source: Field survey; 2014

According to table 4.16 the majority of respondents' (83.8) disclosed that they get training as planned by the government and NGOs, but from the 174 respondents the only 99 responded this question and the rest was missing value. It is clear that the communities needing training regarding new irrigation technologies are not getting it when they most need it. According to farmers at focus group discussions, even though the government and NGOs tried to give training about how to implement new irrigation technologies it is not enough, thus this is an important factor in farmers' non-use of irrigation equipment.

As planned by the Government and NGOs, the training cannot bring about the desired effects on the production and productivity of irrigated agriculture. The survey also revealed that low level of capacity building in terms of training and exchange visits has contributed to the inefficiency

of irrigation-using farmers. It should not be surprising, therefore, that the attitude of many farmers in the study area to the use of new irrigation technology has become negative.

4.4.4. State of Farmer Training Centers (FTCs)

FTCs are identified as a critical resource needed to enable extension delivery in Ethiopia currently. It is designed as local-level central points for farmers to receive information, training, demonstrations, and advice, and included demonstration fields. Therefore the FTCs are expected to form an important joint between extension and farmers in the agricultural sector. Let us witness following table about this issue.

Table 4.17:Closeness of Farmer Training Centers

		Count	Column N %
Is there any Farmer Training Centre near you?	Yes	171	98.3
	No	3	1.7

Source: Field survey; 2014

As we can see from table 4.17 about 98.3% of respondents revealed that there is a nearby FTC while the only few number of respondents have no any FTC near. Farmers were also asked about the effectiveness and efficiency of local FTCs, and most felt that little had been done at these centers by way of demonstration of the use and success of modern irrigation technologies. The researcher himself confirmed this, and took several photographs of unused, disused, broken irrigation technologies, and concluded that what the farmers had said was true.

Figure 4.3: modern irrigation technologies in FTC

Source: Field survey; 2014

As we can observe from the above picture, the first one is a redundant motor pump in a tank, the 2nd, 3rd and 4th are drip irrigation technologies installed in plots of land but not working, while the last one is a hand pump which is simply in the stock. In conclusion, while an FTC should be a model for farmers, it should provide the necessary services, e.g. information, advice, demonstration, training, always in a timely fashion to meet farmers' stated and known needs, it is failed to do so in the study area.

4.4.5. Evaluation of the Contribution of Extension Personnel

This part of the discussion will be an evaluation of the extension personnel's performance from a different perspective, i.e. contributing to the development of irrigation use in the study area, mainly from the outlook of resource mobilization, skill of maintaining irrigation technologies, supplying latest information, and their perceived commitment.

4.4.5.1. Resource Mobilization

Resource mobilization is one of the most important variables which can affect the utilization of modern irrigation technologies. According to Van Den Ban and Hawkins (1988), the main aim of extension programmes is to initiate change, to bring about sound agricultural development, especially on the part of smallholder farmers. It offers them technical advice and also supplies them with the necessary inputs and services. The following table demonstrates farmers' views on the quality of extension personnel in mobilizing resources for farmers.

Table 4.18: Quality of Extension Personnel in Mobilizing Resources

		Count	Column N %
Resource Mobilization	Poor	114	65.5
	Average	32	18.4
	Good	28	16.1
	v.Good	0	.0
	Total	174	100.0

Source: Field survey; 2014

As we can see from table 4.18, the majority of respondents (65.5%) expressed regret that extension agents are poor in mobilizing resources for farmers. If the extension personnel are poor in mobilizing resources for farmers the farmers may not inspired to utilize new technologies. Concerning this issue, the same answer was disclosed during focus group discussions. Furthermore, extension agents themselves accept what had been said by respondents and at focus group discussions.

In this case, the major role of extension personnel should be to equip farmers with sufficient and appropriate resources, training, advice, e.g. information on where to source spare parts.
From farmers' responses, we can conclude that there is a problem of resource mobilization by extension personnel in the study area, which often leads to ineffective use of modern irrigation technologies.

4.4.5.2. Maintenance Skill

Maintenance Service is assigned with the overall responsibility for keeping the irrigation technology working in a satisfactory manner, in this way extension agents have a great responsibility to teach farmers how to maintain new irrigation technologies because farmers may have no know how about how to preserve broken technologies. Pertaining to this matter the following table will show us briefly what is going on in the study area.

Table 4.19: Proficiency of Repairs

		Count	Column N %
Maintenance skill	Poor	26	14.9
	Average	72	41.4
	Good	63	36.2
	v. Good	13	7.5

Source: Field survey; 2014

The above table demonstrates that the maintenance skills of extension agents are 'average' to 'good' according to the responses of three-quarters of farmers questioned. This implies that Extension agents are not good enough in supporting farmers in maintenance time; accordingly this can affect the utilization of new irrigation technologies. In brief, there is a lack of skill in

supporting farmers in the maintenance of broken or non-functioning modern irrigation technologies in the study area.

4.4.5.3 Supplying Up-to-Date Information

Having access to the most up-to-date information on the topic is fundamental to the development of anything in agriculture, indeed in any field of endeavor. Where the introduction, implementation and maintenance of irrigation strategies are concerned, extension personnel need to know and have access to recent developments and studies worldwide, in order to appropriately advise farmers and communities. The views of farmers in this study can be seen in the following table:

Table 4.20: Providing Up-to-Date Information

		Count	Column N %
Giving up to date information	Poor	7	4
	Average	72	41.4
	Good	75	43.1
	v. Good	20	11.5

Source: Field survey; 2014

Table 4.20 shows that the majority of respondents (43.1%) responded that extension agents are 'average' in supplying the latest information about irrigation technologies. This entails that there is room for improvement as far as information about new technologies is the giant power for the farmers.

During the focus group discussion it emerged that the information from extension workers is scarcely about the use of the modern irrigation technologies, but largely on the adoption of other new farm inputs like fertilizer, convincing farmers to take credit and other political agendas. Based on these findings, we conclude that there is a problem on lack of concentrated information about new irrigation technology practices in the study area.

4.4.5.4. Commitment

Motivation of extension personnel must be seen as a key factor in determining the success or failure of the irrigation technology development programme to the extent that motivated individual will be more effective in motivating small group of people, with whom one is working closely. The subsequent table will notify what respondent farmers articulated in the study area.

Table 4.21: Dedication of Extension Personnel

		Count	Column N %
Commitment	Poor	7	4
	Average	57	32.8
	Good	87	50
	V. Good	23	13.2

Source: Field survey; 2014

Table 4.21 shows that, when farmers in the study area were asked about the commitment and dedication of the extension workers, 50% of respondents opted for 'average'.As explained earlier, an enthusiastic individual will be more effective in motivating a small group of people with whom s/he is working closely.

However, as understood from the discussions and practical observation in the field, the reality on the ground is far from ideal. There is high turnover of qualified and well experienced extension staffs, said to be due to the poor salary levels. This is negatively affecting the development and utilization of new irrigation technologies in the study area.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

This chapter presents conclusions and recommendations based on the findings of the preceding chapter. In inspection of that the overall analysis is summarized briefly and possible Recommendations are also forwarded.

5.1. CONCLUSION

Although irrigation has a short history in the study area, its role as a coping mechanism to mitigate the effects of draught cannot be overstated. The majority of farmland is under rain-fed cultivation, with only little plot of land cultivated by distributing water with the help of modern irrigation technologies.

With regard to the prospects of effective utilization of irrigation technologies in the study area, the result of the survey has shown that availability of labour, agro-ecology, access to money, access to markets and support of government and NGOs were identified as major factors which can be prospect for utilization of new irrigation technologies. Concerning the labour force, the majority of farmers (72.4%) reveal that they have adequate labour. Also, according to the majority of respondent farmers, access to markets and finance, along with the nature of the agro-ecological zone contribute positively to development of irrigation technology programmes, particularly if they can rely on a proper extension/advisory service provide by Government and NGOs.

While the shared view is positive, the farmers continue to point to the challenges. The difficulty in maintaining new irrigation technologies is one; concerning this issue, the finding of this study shows that almost 94.3% of the farmers responded with regret that new irrigation technologies are not simple to maintain and this should be addressed. The second challenge was lack of access

to spare parts and shortage of water; according to the finding of the study, those two variables are the most serious challenges hindering irrigation development.

In addition to that, the income possible from non-crop producing activities is found to be a major inhibitor in the development and utilization of irrigation technologies in the study area; however, this income is very important to many and they are slow to relinquish such opportunities. An enormous number of respondent farmers (76.4%) are engaged in non crop-producing income activities, e.g. daily labouring, security work, food for work schemes, and sale of local beverages, bee keeping, and the husbandry of cattle, sheep, goats and poultry. The study also revealed that lack of training, uncertainty about new irrigation inputs and lack of know-how are some of the main problems that are militating against the development and use of irrigation development in the study area.

It is obvious that farmers should have access to clear and updated information and know-how about new irrigation technologies in order to utilize it effectively. To this end, extension personnel have a major role. Accordingly, the study tried to assess the situation on follow-up and visits by extension agents, and found that farmers have no problem with the frequency of contact with the extension personnel, but with the timing and what occurred during the visits.

Another aspect of the extension service which concerns farmers is the Farmers Training Centers (FTCs). It is obvious that the local FTC should be a model for farmers, a demonstration area, a source of information, advice and training, where all aspects of agriculture in the area receive due attention; but, from our study, this is mostly not the case. Concerning the mobilization of resources for farmers, the majority of respondents (65.5%) reveals with regret that extension agents are poor, and often blamed for ineffective exercise of modern irrigation technologies. Furthermore, there is still a problem in supporting farmers who need to repair and maintain broken or non-functioning modern irrigation technologies.

While many farmers feel that the input of extension workers is average to good, their dedication, commitment and enthusiasm would be at a higher level if they received a better salary and an appropriate job description.

5.2 RECOMMENDATIONS

Based on the findings and conclusions of the study, the following recommendations and policy implications are appropriate to various levels of decision makers.

- There are several areas in the region which are conducive to crop production, and many opportunities for stakeholders, e.g. government and financial institutions, NGOs to become involved in development. A commitment to communication and co-operation, not least with farmers, should be instituted to exploit such opportunities, and this should be expanded to many parts of the region.
- Farmers should get sufficient training on installation, repair and maintenance of irrigation technologies, e.g. drip, treadle pump and motor pumps, by developing institutional relationships with the trainers and service providers, in a manner that can enhance the utilization of new irrigation technologies.
- While disseminating new irrigation inputs, anybody or agency involved should not forget the importance of access to spare parts locally, to replace broken or non functional parts of new irrigation technologies. In this business, it is more beneficial to have an access of spare parts available; FTCs and NGOS involved should ensure to have such parts in stock.
- As direction the government is trying its best in mobilizing farmers to owe individual one or more than one water opportunities as water is the fundamental ingredient in the practice of irrigation. But there is still a gap; farmers demonstrated that they have a shortage of access to cement and other materials which can contribute to construction of water tankers thus, those necessary equipments should be supplied in different ways such as in credit. Beside to that the support from NGOs should be continuous mainly in diversion of streams and constructing min-dams in the upper side of the study area.

- It is obvious that Non-crop activities play a prime role: directly, by contributing considerably to rural household income; and indirectly, by influencing agricultural activities with potential implications for sustainability. Pressure on natural resources

may be reduced when households have alternative sources of income. But this practice is affecting utilization of new irrigation inputs. Therefore great awareness creation should be done farmers to be certain about new irrigation technologies, mainly using FTCs and any demonstration centers that using irrigation technology has a great effect beside to that nonfarm activate.

- Extension service should be streamlined and improved. Irrigation experts should be carefully trained and shown how to access all the latest information and know-how. They need to continually consult farmers on follow-up visits, and ensure that such visits meet farmers' needs; to do so a proper career structure should be instituted for extension personnel, with attention to salary levels and clear job descriptions.

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Annex I

Mekelle University, College of Business and Economics
Department of Management
Development Studies
Questioner felt by respondent farmers in woreda Ganta-Afeshum

This questionnaire is prepared by Mr. Hagos Niguse a postgraduate student in the Department of Management (Development Studies) of Mekelle University. It is prepared to gather primary data about Challenges and Prospects of Utilizing Irrigation Technologies in Ganta-Afeshum Woreda. The data will be used for academic purpose only. I assure you that, all your responses will be kept in absolute confidence and you will not be held responsible for any of outcomes followed by the study.

Therefore, your genuine and timely responses are vital to determine the success of this study. Hence; I kindly request your collaboration in filling the questionnaire honestly and responsibly. I thank you in advance for your willingness to give me information sacrificing your precious time

Survey area (District, Kebele) _____

Enumerator Name_____

Date_____

General instructions

1. No need of writing your name
2. Please put your answer as circle in each case
3. Use the blank space for open-ended questions
4. Please attempt all parts accurately as possible and at your earliest time.

Thank you!

Hagos Niguse, Survey coordinator

1-Personal Data /household Characteristics

1.1. sex of the respondent;

1. Male: _____

2. Female: ____

1.2. Age group of the respondent.

1. 18-33 2. 34-49

3. 50-64 4. More than 65

1.3. Literacy level of the respondent

1. Illiterate ___

2. Read and write only ___

3. Elementary __

4. High school complete ___

5. Diploma and above

1.4. Marital status of the respondent

1. Married 2. Widowed

3. Divorced 4. Unmarried

1.5. How do you categorize your household size?

1. Small 2. Enough

3. Large 4. Excessive

1.6. Who is the main economic provider for the household? (put in order of importance)

1. Husband 2. Spouse

3. Son/ daughter 4. Relatives in the household

5= relatives somewhere else

2. Opportunities to Use Irrigation Technologies

2.1. Do you have labor shortage in operating your irrigation farm? 1= yes 2= no

2.2. If yes for question 2.1 what other opportunities do you use? _____

2.3. Do you have water access for your irrigation practice? 1=yes 2=no

2.4. If you have security of water what source of water do you use?

1= river/stream 2= shallow dug out

3= natural pond 4= artificial pond/dam

2.5. If you have scarcity of water source what measures did you take?

1. Decide not using modern irrigation technologies
2. Excavate bore wholes
3. Saving rain water 4. 2and 3

2.6. Patterns of rain fall in your area?

1= decrease 2= no difference 3= increase

2.7. Total land size _____ (you can use hectare or local measurement)

2.8. How do you view the quality of your farm land?

1= very poor 2= poor 3= adequate 4= fertile

2.9. If your response is poor or very poor, indicate factors that contributed (you can choose more than one).

1=Soil erosion
2= no using of irrigation technologies
3= continuous cropping/grazing
4= little or not using fertility inputs
5= others (specify) ----------

2.10. Do you feel secure that the land belongs to you? 1= yes 2= no if no why_____

2.11. Explain the agro ecological zone of your Kebele?

1= Dega 2= Woina Dega 3= kola

2.12. Do you think that your agro ecological zone is conducive to produce different products using new ITs? 1=yes 2= no if your answer is yes or no reason out?

_____

_____

_____

2.13. Do you have money to buy spear parts to maintain your new irrigation technologies? 1= yes 2=no if your answer is no what other opportunities do you use?

_____

_____

2.14. How do you evaluate the support of government and NGOs to practice your irrigation with new ITs? 1= very poor 2= unsatisfactory 3= satisfactory 4= very satisfactory

2.15. Do you have market access for your produce? 1=yes 2=no

2.16. What types of opportunity do you have in your area to fully utilize new irrigation technologies?

---

3. Challenges of utilizing Irrigation Technology

3.1. What type of new irrigation technologies do you have/ (you can choose more than one).

1= drip 2= treadle 3= motor pump 4= row pump 5=others (specify)……

3.2. How do you get those irrigation technologies? (You can choose more than one).

1= through own money

2= through government

3= NGO 4= 2&3 5= through all

3.3. Is the irrigation technology you use is simple to maintain? 1. Yes 2. No

3.4. If the answer to Q3.3. Is No, what is beyond your ability? _____

_____

3.5. Do you get the spare parts simply to maintain your irrigation technologies in nearby area? 1=yes 2= no if no from where do you get? _____

3.6. For how long have you been practiced new irrigation technologies?

1=more than three years 2= two years 3=one year 4= six months

3.7. Do you think that irrigation technologies are vital? 1= yes 2= no if no why? _____

_____

_____

3.8. Do you have enough water for irrigation practice? 1 =Yes 2=No if no what other opportunities do you use?

_____

3.9. State the kinds of support that you need in relation to the irrigation technology?

_____

_____

_____

3.10. Do you borrow money? 1= yes 2= no if yes from whom? (You can choose more than one).

1=Privet lenders 2=through relatives 3=Friends

4=Banks 5=NGOs 6=Cooperatives

3.11. If yes, why? (You can choose more than one).

1= to purchase oxen 2= to purchase fertilizers 3= to buy modern irrigation technologies

4= to construct house 5=1&2 6=1&3 7=1&4 8=2&3 9=2&4 10=3&4

5= others (specify) _____

3.12. Do you have experience of default on your repayment before? 1= yes 2= no

3.13. If you do not borrow, why not?

1= fear of being in debt 2= fear of failure to repay 3= I don't need credit

5= others (specify_____

3.14. List of important factors which most inhibit your irrigation technology utilization at present?

Factors	Rank	Extent of the problem		
		Simple	Modest	Considerable
lack of training				
Lack of inputs				
shortage of labor				
uncertainty about new Its				
water scarcity				
lack of marketing for produce				
lack of know how				
Lack of finance				

Lack of skill				
Absence of gov't support				

If other (specify) _____

3.15. Have you ever faced a problem of crop failure when using ITs? 1= yes 2= no

3.16. If yes, why? (You can choose more than one).

1= water shortage 2= crop disease 3= poor ITs practice

4= over flooding of the farm

5= 1&2 6=1&3 7=1&4 8=2&3 9=2&4 10=3&4

11=others (specify) _____

3.17. Do you irrigate all of your irrigable land? 1= yes 2= no

3.18. If not why? (You can pick more than one option)

1= shortage of water

2= low productivity

3= getting sufficient produce by rain feed agriculture

4= poor quality of irrigation technologies

5= poor maintenance

6= others (specify) _____

3.19. Do you use any non-crop activates than practicing irrigation? 1=yes 2= no

If yes why and in what kind of non-crop activates are you engaged?

_____

3.20. What can you recommend for the successfully use of new Irrigation Technologies? (You can choose more than one).

1=Access of credit service 2=Access of training

3=Access of spare parts 4=Access of water

5=all 6=others (specify) _____

4. Follow up of the extension workers

4.1. Have you ever visited by an extension agent? 1= yes 2= no

4.2. If yes for q 4.1 for how many times

1=always 2= sometimes 3= rarely

4.2. If yes, for q4.1 during which operation? (You can pick more than one option)

1= irrigation technology preparation times

2= planting/transplanting times

3 = maintenance times

4= applying agro chemicals times

5= watering times

6= harvesting times

7=all

4.3. Did you receive support from development agents? 1=Yes 2=No

4.4. If yes for q4.3 what are the support given? (You can pick more than one option)

1=Technical 2=Experience sharing 3=Controlling water distribution

4=others (specify) _____

4.5. Did you ever take training on operation and maintenance of the new irrigation technologies?

1. Yes 2. No

4.7. If your answer is yes for Q. 4.5 how many times?

1 .Once per irrigation season 2. Once per year

3. As required by the community 4. As planned by the Government and NGOs

6. Other (specify) _____

4.8. How often do you get information about IT?

1= always 2= occasionally 3=rarely 4=never

4.9. Do you simply understand the information from DAs or extension services?

1=yes 2=no 3=if not why_____

4.10. How relevant do you think the information that you got?

1= Not relevant 2=little relevant 3=relevant 4=very relevant

4.11. If 1& 2 for q 4.10 what are your reasons _____?

4.11. Is there any nearby farmer's training center? 1=yes 2=no

4.12. Express the support that you need from extension workers concerning irrigation technology_____

_____

_____

_____

_____

4.13. How do you evaluate the performance of the extension workers with regard to the following functions?

Activates	Extent of the performance			
	Poor	Average	Good	V. Good
Guidance skill				
Resource Mobilization				
Maintenance skill				
Giving up to date information				
Commitment				
Organizing efforts				

4.14. Put any recommendation that can contribute for adequate extension services?

_____

_____

_____

_____

_____

_____

_

ANNEX 2

Interview guide for key informants

1. What opportunities do you have in your area to use modern irrigation technologies?
2. What looks like the support of government and non-governmental organizations for development of utilization of irrigation technologies?
3. How do you view the strength and weaknesses of the irrigation systems? (In relation to technical aspects)
4. What are the existing policies in relation to agriculture in general and irrigation in Particular and how do you view them?
5. What are the main challenges that hinder the utilization of irrigation technologies?
6. What do you think the main solutions for those challenges?

Guiding questions for focus group discussions

1. What looks like the condition of utilizing irrigation technologies in your area?
2. What prospects do you have to practice irrigation?
3. What is your feeling towards new irrigation technologies in terms of productivity and simplicity in operation?
4. What are the main challenges that hinder the operation of new irrigation technologies?
5. How can you address those problems?
6. How can you see the follow up and support of government and non-governmental organizations for the mounting of irrigation use?
7. What can you recommend for the full utilization of new irrigation technology?

THANK YOU!